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3,131,457

STRESS PEENING MACHINE

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8 Claims. (Cl. 29—90)

This invention relates to machines for shot-peening workpieces, and more particularly to machines for subjecting workpieces to stress-peening processes. The term "stress-peening" refers to the operation of shot-peening a part while it is statically stressed in the same direction as the stress which is to be sustained when the part is in service. Still more specifically, the present invention relates to machines for stress-peening workpieces of the leaf spring type such as are currently employed in automotive vehicle suspension systems.

Leaf springs are conventionally fabricated by hot rolling or otherwise shaping spring steel or other spring material into the required shape. The ends of the blanks are then curled to form eyes for receiving the mounting shackle bolts. The blades are then heat-treated to hardening temperature and then quenched and tempered. It has been determined that if the spring blade is now shot-peened while under load, it will possess improved strength and life characteristics, whereby for a given weight suspension problem a spring of reduced size and weight may be successfully employed. The features and advantages of fabricating a spring part by means of such a stress-peening operation are more fully set forth and explained for example in U.S. Patent 2,608,752.

The primary object of the present invention is to provide an improved machine into which previously shaped and hardened and tempered spring leaves may be loaded by mounting them in sequence onto a moving conveyor while in unstressed attitudes, whereupon they are automatically stressed and then carried into the range of shot-peening equipment, and subsequently released from their stressed conditions before delivery from the machine, all in automatically controlled manner.

By way of example, a machine embodying the features of the invention is illustrated by the accompanying drawings wherein:

FIG. 1 is a side elevational view of the machine;

FIG. 2 is a longitudinal vertical sectional view thereof in edwise reversed relation;

FIGS. 3 and 4 are fragmentary sectional views taken along lines III—III and IV—IV, respectively, of FIG. 2;

FIG. 5 is an enlarged scale sectional view taken along line V—V of FIG. 2;

FIG. 6 is a fragmentary plan view taken along line VI—VI of FIG. 5;

FIG. 7 is a detailed view illustrating a portion of the mechanisms of FIG. 5;

FIG. 8 is a top plan view of the portion of the machine shown in FIG. 5;

FIG. 9 is a fragmentary end elevational view of the apparatus of FIG. 5, showing a leaf spring mounted therein in unstressed condition;

FIG. 10 is a fragmentary plan view taken along line X—X of FIG. 5;

FIG. 11 is a view corresponding to FIG. 9 but showing a mounted spring leaf therein in stressed condition preparatory to the shot-peening operation;

FIG. 12 is a fragmentary plan view taken along line XII—XII of FIG. 11;

FIG. 13 is a fragmentary plan view taken along line XIII—XIII of FIG. 5;

FIG. 14 is a fragmentary perspective of a detail of the apparatus of FIGS. 9—13;

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FIG. 15 is a fragmentary sectional view taken along line XV—XV of FIG. 11;

FIG. 16 is an enlarged scale fragmentary elevational-sectional view of the right hand end portion of FIG. 2;

FIG. 17 is an enlarged scale fragmentary sectional view taken along line XVII—XVII of FIG. 5;

FIG. 18 is a fragmentary view similar to FIG. 17 but showing the mechanism in a different operative position;

FIG. 19 is an enlarged scale sectional view taken along line XIX—XIX of FIG. 5;

FIG. 20 is enlarged scale fragmentary view of a detail of FIG. 5;

FIG. 21 is an enlarged scale sectional view taken along line XXI—XXI of FIG. 5;

FIG. 22 is a fragmentary schematic view of a portion of the machine transport conveyor motion equalizer device;

FIG. 23 is a fragmentary sectional view through a portion of the machine at the left hand end of FIG. 2; and

FIG. 24 is a schematic of a control system for the machine of the invention.

General Description

The invention contemplates generally a machine comprising major components including an endless work carrying conveyor arranged to be automatically advanced in step-by-step manner to accommodate manual loading thereon of leaf springs to be stress-peened. After being mounted on the conveyor the springs are subjected to stressing actions which bow them out of their relaxed attitudes and in the directions of their stressed conditions when in use. They are then transported into range of shot-peening equipment where they are subjected to peening action for a predetermined period requisite to provide the desired strengthening effect. The springs are then carried by the conveyor out of the shot-peening chamber toward the delivery end of the machine; the springs being incidental thereto automatically released from their stressed attitudes so that when they reach the discharge end of the machine they are in relaxed condition and free to leave the conveyor. An attendant may then manually lift the finished springs from the work conveyor; or, they may simply be permitted to roll forwardly and tumble downwardly from the conveyor, as may be preferred. Operation of the various actuating devices for accomplishing the above mentioned processes are automatically synchronized and relatively timed so as to provide the displacement and timing functions requisite to obtain the desired results. The operative components and their modes of functioning will now be described in more detail.

The Work Conveyor

As shown in the accompanying drawing, the work conveyor is indicated generally at 30 and is shown as comprising parallel running endless chains 32—32 disposed at opposite sides of the machine and arranged to train around sprockets 34, 35 and rollers 36, 36 at opposite ends of the machine. The sprockets 35 are keyed to a cross shaft 38 which is driven to rotate in stepping manner by means of a ratchet-pawl device 40 (FIG. 1) which is powered by a hydraulic cylinder 42. The cylinder 42 is actuated by the control system, as will be explained hereinafter, in such manner as to advance the work carrying conveyor intermittently in step-by-step manner while carrying the spring parts to be treated as indicated at 43 through the machine. The conveyor chains are fitted at intervals with slide pads 31 which slide in guided relation upon rails 33 at opposite sides of the machine. The conveyor chains 30—30 are interconnected by cross-

wise disposed fixtures which comprise parallel disposed bars 44—44 which extend transversely of the conveyor and at intervals lengthwise thereof, and are adapted to receive the springs to be treated in mounted relation upon the conveyor.

The Spring Stressing Component

Retaining clamps 45—45 are pivotally mounted upon opposite ends of the fixture bars 44 and are so arranged that as their corresponding fixture bars come up into spring receiving positions, the clamps 45—45 are disposed in "open positions" whereby the springs to be treated may be readily disposed between the clamps while in unstressed condition. Rest blocks 46—46 are carried by the fixture bars 44 adjacent each clamp for vertical support of the springs 43 when being engaged by the clamps. Control arms 47, 47 (FIGS. 5, 9—11) carried by a cross beam 49 are then forced by hydraulic jacks 48, 48 to pivot inwardly and to press the clamps 45, 45 toward one another so as to close over the eye portions of the workpieces in holding relation, as shown for example in FIGS. 4, 5, 9 and 10.

At an early stage of the progress of each workpiece through the machine a ram device as indicated at 50 automatically rises and engages the central portion of the part 43 and displaces it upwardly while the ends of the part are held down by the clamps 45—45. The spring is then locked in its stressed attitude by means of a block 52 which is carried by the fixture and is swung about a mounting pivot pin 54 (FIG. 14). The ram then withdraws to repeat its operation as the conveyor indexes to bring another workpiece 43 into registry with the ram device. The stressed parts then proceed through the shot-peening portion of the machine which is indicated generally at 60 (FIGS. 1, 2) and comprises an enclosing cabinet-like structure mounting one or more shot throwing machines such as are indicated at 61, 62, 63, 64. Means for supplying the machines 61—64 with shot and for gathering and reconditioning and returning the spent shot will of course be provided, as is well known in this art, but these parts are not illustrated herein because they per se form no part of the present invention.

As shown herein, the beam structure 49 comprises a pair of channels forming the cap piece of a vertically standing frame structure which includes opposite side columns 70—70; the frame piece 49—49—70—70 being arranged to straddle the workpiece conveyor. The frame may either be stationary or arranged to reciprocate lengthwise of the machine in synchronism with indexing movements of the workpiece conveyor for momentarily traveling with the conveyor if it is preferred not to delay the conveyor motion while the ram 50 is stressing the workpiece, as will be explained more fully hereinafter. In any case the ram 50 is carried by a horizontally disposed cross beam 72 which is vertically slidable on the columns 70—70 as controlled by fluid pressure cylinders 74—74. A cylinder 76 which operates an actuator 78 (FIGS. 5—14) is pivotally carried on the beam 72 for engaging and swinging the holding block 52 into position under the workpiece when the ram is in raised position against the workpiece. To provide this action the pivot arm 54 of the holding block is formed with a crank arm 79 which is connected to the actuator 78. The vertical motions of the opposite ends of the beam 72 are equalized by means of chain devices 82, 84 which are dead-ended as indicated at 83, 85 to the side columns 70—70 and intermediately thereof train around pulleys 86 which are carried by the cross-beam (FIGS. 5, 20, 22).

As stated hereinabove, the mechanism is operated so that the ram 50 acts upon each workpiece as the conveyor brings them successively into the region of the stressing frame so as to first elastically deform the spring into upwardly bowed position, as shown, in FIG. 11. This substantially duplicates the condition of the spring when it is installed in an automobile or the like for op-

erative service. The holding block 52, which is carried by the fixture in which the spring is cradled, is then swung into position under the upwardly bowed portion of the spring by operation of the cylinder 76 which is also carried by the vertically moving cross-beam 72. The cylinders 74—74 controlling the position of the ram beam 72 then operate to lower the latter so that the actuator 78 drops out of contact with the holding block crank arm 79 and clear of the path of travel of the fixtures 44. The ram 50 of course coincidentally retracts downwardly away from the spring, to a position where it also clears the fixture bars 44. The work carrying conveyor is then free advance as explained hereinabove, for carrying the now stressed workpieces 43 successively through the blasting chamber 60. It will be noted that the surfaces of the workpieces which are under tension are exposed to the shot blasting operation as they travel through the chamber 60, and due to the spacings of the fixtures 44 the adjacent workpieces are suitably spaced apart so that the shot blasting operation may be performed against substantially all surface areas of the workpieces.

The Workpiece Unloading Operation

The workpiece unloading operation is performed in a manner and through use of mechanism substantially similar to the mechanism and method of operation described hereinabove in connection with the workpiece loading and stressing operations, except that the unloading operation is of course performed in reverse manner. Thus, as shown in FIGS. 1, 2, a framing structure is provided to straddle the work conveyor adjacent the unloading end portion thereof and may comprise vertical columns 90—90 and a cap piece 92 which is similar to the post and cap piece construction 70—49 at the loading end portion of the machine. A vertically movable cross-beam 96 is carried within the frame structure, as in the manner of the cross-beam 72 of FIG. 5 and supports an "unloading" ram device 94 (FIG. 2) which is the counterpart of the ram 50 described hereinabove. The ram carrying beam is arranged to be vertically moved as in the manner of the beam 72 by means of cylinders 98 (FIG. 1) disposed at the opposite sides of the machine.

The mechanism is controlled so that as each fixture 44 carrying a spring which has been peened during passage through the chamber 60 emerges from the blast chamber, the ram 94 rises from therebelow and engages the central portion of the spring and lifts it free of its holding block 52. At the same time, an actuator (not shown) identical to the actuator 78 of FIG. 5 is controlled by a cylinder (not shown) similar to cylinder 76 of FIG. 5 to move against the crank arm of the holding block unit, thereby camming the block out from under the spring. The ram 94 thereupon lowers and thereby releases the workpieces to return to its normal unstressed condition as shown in FIG. 3, whereupon it simply hangs on its resting pads 46—46. The conveyor then moves to index the fixture into position below a pair of clamp release arms 100—100 (FIG. 23) which are carried by the cap beam 92 and are arranged to be actuated by cylinders 102—102 in such manner as to push outwardly against the holding clamps 5 and to "open" them so as to remove the downholding restraint of the clamps against the ends of the spring. Thus the springs now lie loose in their cradles and may be manually removed or simply permitted to tumble out of the fixtures as the conveyor further advances.

As shown in FIG. 4, a blow-off cleaning spray may be arranged to project against the workpieces after they emerge from the blast cabinet 60; and as shown in FIG. 4 the spray may be provided by means of one or more compressed air conduits 110 having jet nozzles directed against the workpieces as they are carried by the fixtures 44 toward the discharge end of the machine.

As stated hereinabove, it may be preferred not to delay the motion of the work carrying conveyor during

the operations of ramming and locking the workpieces in stressed positions, and while reversely releasing the workpieces preparatory to discharge from the machine. In such case the framing structures carrying the ram and locking devices may be mounted on rails at opposite sides of the machine so that the frames may reciprocate in directions lengthwise of the machine. This permits the frames to temporarily "travel" with the conveyor while the ram and lock devices are in operation. Thus, as shown in FIGS. 17-18, the cap beam 49 of the workpiece stressing frame structure supports a bell crank as indicated at 120 which is pivotally mounted as indicated at 122 on the beam. The crank 120 includes an integrally extending arm 124 which connects at 125 to one end of a tension spring 126, the other end of which is fixed to a bracket 127 carried by the beam 49. The bottom leg 128 of the bell crank 120 is vertically sloped at its bottom surface so as to be adapted to cam over (FIG. 18) a cap piece 130 which is carried by each of the fixtures 44. The crank arm 128 is latch-shaped as indicated at 132 so as to be adapted to drop down in locking relation upon the fixture bars 44 (FIG. 17). Thus, whenever the bell crank 120 cams over and locks upon a fixture 44, the entire frame structure is then carried forwardly with the conveyor for a predetermined distance. Subsequently, impact of the bell crank 120 against a trip bar 134 releases the bell crank from the fixture and permits the conveyor to "escape" from the frame structure. A hydraulic cylinder arrangement as indicated at 140-140 thereupon operates to return the frame structure to its starting position where it is subsequently re-engaged by another fixture, for repetition of the above described operation.

As explained hereinabove, actuation of the various operative components of the machine of the invention may be automatically synchronized and relatively timed so as to provide the requisite operative motions and timing functions; and it will of course be appreciated that any preferred form of automatic or semi-automatic control system may be employed. FIG. 24 schematically illustrates a suitable control system by way of example only; it being understood that no invention is claimed for this control system and/or its components per se. Thus it will be understood that the operative mechanisms of the machine may be separately powered and either manually or automatically controlled and synchronized so as to automate the entire apparatus, as may be preferred; and that although only one example of the invention has been illustrated and described herein various changes may be made without departing from the spirit of the invention or the scope of the accompanying claims.

What is claimed is:

1. A machine for stress-peening elastic workpieces, comprising an endless conveyor defining a workpiece carrier, said conveyor including a succession of relatively spaced workpiece carrying fixtures disposed transversely of said conveyor, each of said fixtures mounting workpiece clamp means at opposite ends of said fixture for receiving corresponding ends of a workpiece when disposed therebetween, cam means mounted independently of said conveyor in registry with the path of movement of said clamp means and operable to cam the latter into workpiece clamping positions upon arrival of a workpiece carrying fixture at the position of said cam means, a vertically movable ram mounted independently of said conveyor and movable into abutting position against the workpiece upon arrival thereof at a further position of travel of said conveyor and operable to engage the workpiece and to deform it elastically while being held at its opposite ends by said clamp means, a holding block carried by each of said fixtures and movable into position between the fixture and the elastically deformed portion of the workpiece upon arrival of said workpiece at still another position of travel, means operable thereupon to withdraw said ram from workpiece contacting position, a shot-blast-
2. A machine for stress-peening elastic workpieces, comprising an endless conveyor defining a workpiece carrier, said conveyor including a succession of relatively spaced workpiece carrying fixtures disposed transversely of said conveyor, each of said fixtures mounting workpiece clamp means at opposite ends of said fixture for receiving corresponding ends of a workpiece when disposed therebetween, cam means mounted independently of said conveyor in registry with the path of movement of said clamp means and operable to cam the latter into workpiece clamping positions upon arrival of a workpiece carrying fixture at the position of said cam means, a frame mounted upon said machine to straddle said conveyor and to reciprocally travel therewith within a short limit of travel, a vertically movable ram mounted upon said frame and movable into abutting position against the workpiece upon arrival thereof at a further position of travel of said conveyor while said frame is travelling with said conveyor and operable to engage the workpiece and to deform it elastically while being held at its opposite ends by said clamp means, a holding block carried by each of said fixtures and movable into position between the fixture and the elastically deformed portion of the workpiece upon arrival of said workpiece at still another position of travel, means operable thereupon to withdraw said ram from workpiece contacting position, a shot-blasting device disposed adjacent said conveyor at a further advanced position of travel thereof for blasting the workpieces as they travel thereby, a second frame similar to said first frame but disposed adjacent the discharge end of said machine, a second vertically movable ram device mounted upon said second frame and movable into position against each of said workpieces upon arrival at a position beyond the position of said shot-blasting device to lift said workpieces free of their holding blocks, means thereupon operable to withdraw the holding blocks from operative position, means thereupon operable to retract said second ram from workpiece contacting position, and means thereupon operable to cam said clamping means out of workpiece holding positions whereby the finished workpieces are free for removal from said machine.
3. A machine for stress-peening elastic workpiece, comprising a frame and an endless conveyor travelling through defining a workpiece carrier, said conveyor including a succession of relatively spaced workpiece carrying fixtures, each of said fixtures having workpiece clamp means at opposite ends of said fixture for receiving corresponding ends of a workpiece when disposed therebetween, cam means mounted on said frame independently of said conveyor in registry with the path of movement of said clamp means and operable to cam the latter into workpiece clamping positions upon arrival of a workpiece carrying fixture at the position of said cam means, a vertically movable ram mounted on said frame independently of said conveyor and movable into abutting position against the workpiece upon arrival thereof at a further position of travel of said conveyor and operable to engage the workpiece and to deform it elastically while being held at its opposite ends by said clamp means, a holding block carried by each of said fixtures and mov-

able into position between the fixture and the elastically deformed portion of the workpiece upon arrival of said workpiece at still another position of travel, means operable thereupon to withdraw said ram from workpiece contacting position, a shot-blasting device disposed adjacent said conveyor at a further advanced position of travel thereof for blasting the stressed workpieces as they travel thereby, a second vertically movable ram device mounted on a second frame portion independently of said conveyor and movable into position against each of said workpieces upon arrival at a position beyond the position of said shot-blasting device to lift said workpiece free of its holding block, means operable upon further travel of said conveyor to withdraw the holding blocks from operative position, means thereupon operable to retract said second ram from workpiece contacting position, and means thereupon operable to cam said clamping means out of workpiece holding positions whereby the finished workpieces are free for removal from said machine.

4. A machine for stress-peening elastic workpieces, comprising a trackway and an endless conveyor travelling thereon defining a workpiece carrier, said conveyor including a succession of relatively spaced workpiece carrying fixtures, each of said fixtures mounting workpiece clamp means at opposite ends of said fixture for receiving corresponding ends of a workpiece when disposed therebetween, cam means mounted on said frame independently of said conveyor in registry with the path of movement of said clamp means and operable to cam the latter into workpiece clamping positions upon arrival of a workpiece carrying fixture at the position of said cam means, a frame mounted upon said machine to straddle said conveyor and to reciprocally travel therewith within limits, a vertically movable ram mounted upon said frame and movable into abutting position against each workpiece upon arrival thereof at a further position of travel thereof while said frame is travelling with said conveyor and operable to engage the workpiece and to deform it elastically while being held at its opposite ends by said clamp means, a holding block carried by each of said fixtures and movable into position between the fixture and the elastically deformed portion of the mounted workpiece upon arrival of said workpiece at still another position of travel, means operable thereupon to withdraw said ram from workpiece contacting position, a shot-blasting device disposed adjacent said conveyor at a further advanced position of travel thereof for blasting the workpieces as they travel thereby, a second frame similar to said first frame but disposed adjacent the discharge end of said machine, a second vertically movable ram device mounted upon said second frame and movable into position against each of said workpieces upon arrival at a position beyond the position of said shot-blasting device to further elastically deform said workpieces free of their holding blocks, means thereupon operable to withdraw the holding blocks from operative positions, means thereupon operable to retract said second ram from workpiece contacting position, and means thereupon operable to cam said clamping means out of workpiece holding positions whereby the finished workpieces are free for removal from said machine.

5. A machine for stress-peening elastic workpieces, comprising a frame and an endless conveyor travelling therethrough defining a workpiece carrier, said conveyor including a succession of workpiece carrying fixtures, each of said fixtures having workpiece clamp means for engaging separate parts of a workpiece when disposed therebetween, cam means mounted on said frame independently of said conveyor in registry with the path of movement of said clamp means and operable to cam the latter into workpiece clamping positions upon arrival of a workpiece carrying fixture at the position of said cam means, a vertically movable ram mounted on said frame independently of said conveyor and movable into abutting posi-

tion against a portion of the workpiece between said clamp means upon arrival thereof at a further position of travel of said conveyor and operable to engage the workpiece and to deform it elastically while being held by said clamp means, a holding block carried by each of said fixtures and movable into position between the fixture and the elastically deformed portion of the workpiece upon arrival of said workpiece at still another position of travel, means operable thereupon to withdraw said ram from workpiece contacting position, a shot-blasting device disposed adjacent said conveyor at a further advanced position of travel thereof for blasting the stressed workpieces as they travel thereby, a second vertically movable ram device mounted on a second frame portion independently of said conveyor and movable into position against each of said workpieces upon arrival at a position beyond the position of said shot-blasting device to lift said workpiece free of its holding block, means operable upon further travel of said conveyor to withdraw the holding blocks from operative position, means thereupon operable to retract said second ram from workpiece contacting position, and means thereupon operable to cam said clamping means out of workpiece holding positions whereby the finished workpieces are free for removal from said machine.

6. A machine for stress-peening elongate elastic workpieces, comprising a frame and an endless conveyor travelling therethrough defining a workpiece carrier, said conveyor including a succession of workpiece carrying fixtures, each of said fixtures having workpiece clamp means for receiving parts of a workpiece when disposed therebetween, cam means mounted on said frame independently of said conveyor in registry with the path of movement of said clamp means and operable to cam the latter into workpiece clamping positions upon arrival of a workpiece carrying fixture at the position of said cam means, a ram mounted on said frame independently of said conveyor and movable into abutting position against the workpiece upon arrival thereof at a further position of travel of said conveyor and operable to engage the workpiece and to deform it elastically while being held by said clamp means, a holding block movable into position between the fixture and the elastically deformed portion of the workpiece upon arrival of said workpiece at still another position of travel, means operable thereupon to withdraw said ram from workpiece contacting position, a shot-blasting device disposed adjacent said conveyor at a further advanced position of travel thereof for blasting the stressed workpieces as they travel thereby and means movable into position against each of said workpieces upon arrival at a position beyond the position of said shot-blasting device to release said workpieces free of the conveyor whereby the finished workpieces are free for removal from said machine.

7. A machine for stress-peening elastic workpieces, comprising a trackway and an endless conveyor travelling thereon defining a workpiece carrier, said conveyor including a succession of workpiece carrying fixtures, each of said fixtures mounting workpiece clamp means for receiving parts of a workpiece when disposed therebetween, cam means mounted on said frame independently of said conveyor in registry with the path of movement of said clamp means and operable to cam the latter into workpiece clamping positions upon arrival of a workpiece carrying fixture at the position of said cam means, a frame mounted upon said machine to straddle said conveyor and to reciprocally travel in the direction of said conveyor within limits, a ram mounted upon said frame and movable into abutting position against each workpiece upon arrival thereof at a further position of travel thereof while said frame is travelling with said conveyor and operable to engage the workpiece and to deform it elastically while being held by said clamp means, a holding block carried by each of said fixtures and movable into position between the fixture and the elastically deformed portion of the

mounted workpiece upon arrival of said workpiece at still another position of travel, means operable thereupon to withdraw said ram from workpiece contacting position, a shot-blasting device disposed adjacent said conveyor at a further advanced position of travel thereof for blasting the workpieces as they travel thereby, a second frame similar to said first frame but disposed adjacent the discharge end of said machine, a second ram device mounted upon said second frame and movable into position against each of said workpieces upon arrival at a position beyond the position of said shot-blasting device to further elastically deform said workpieces free of their holding blocks, means thereupon operable to withdraw the holding blocks from operative positions, means thereupon operable to retract said second ram from workpiece contacting position, and means thereupon operable to cam said clamping means out of workpiece holding positions whereby the finished workpieces are free for removal from said machine.

8. A machine for stress-peening elastic workpieces, comprising a trackway and an endless conveyor travelling thereon defining a workpiece carrier, said conveyor including a succession of workpiece carrying fixtures, each of said fixtures mounting workpiece clamp means for clamping parts of a workpiece when disposed therebetween, cam means in registry with the path of movement of said clamp means and operable to cam the latter into workpiece clamping positions upon arrival of a workpiece

carrying fixture at the position of said cam means, a frame mounted upon said machine to straddle said conveyor and to reciprocally travel in the direction of said conveyor within limits, a ram mounted upon said frame and movable into abutting position against each workpiece upon arrival thereof at a further position of travel thereof while said frame is travelling with said conveyor and operable to engage the workpiece and to deform it elastically while being held by said clamp means, a holding block movable into position between the fixture and the elastically deformed portion of the mounted workpiece upon arrival of said workpiece at still another position of travel, means operable thereupon to withdraw said ram from workpiece contacting position, a shot-blasting device disposed adjacent said conveyor at a further advanced position of travel thereof for blasting the workpieces as they travel thereby, and means operable upon said workpieces upon arrival at a position beyond the position of said shot-blasting device to release said workpieces whereby the finished workpieces are free for removal from said machine.

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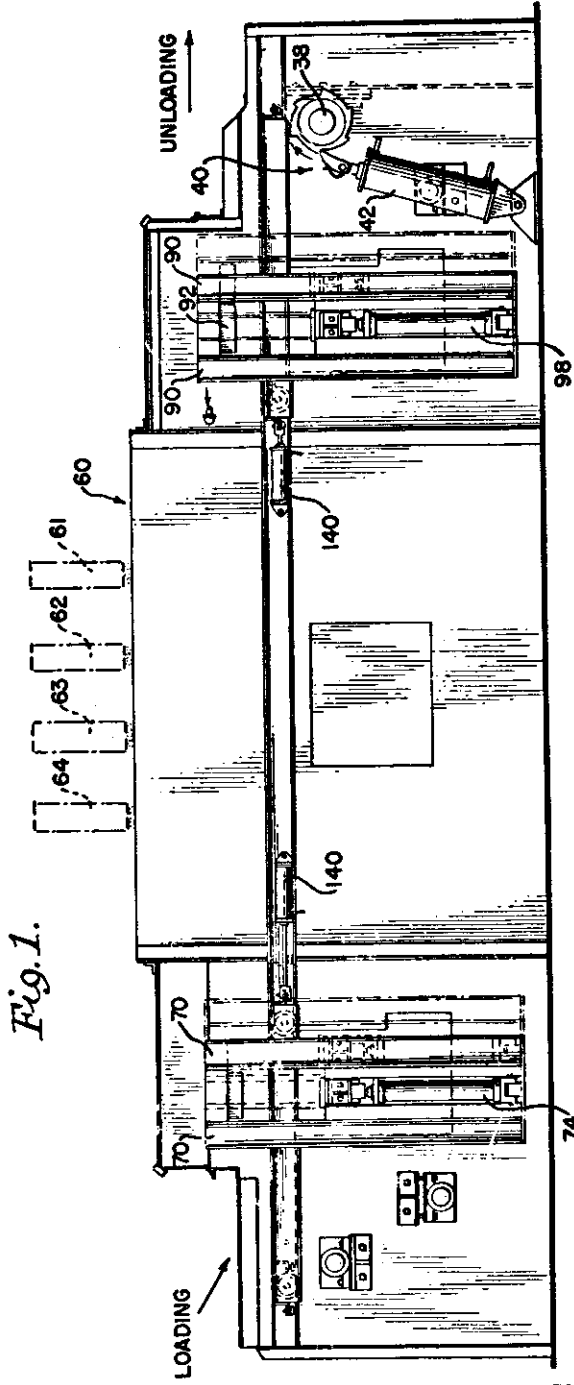


Fig. 1.

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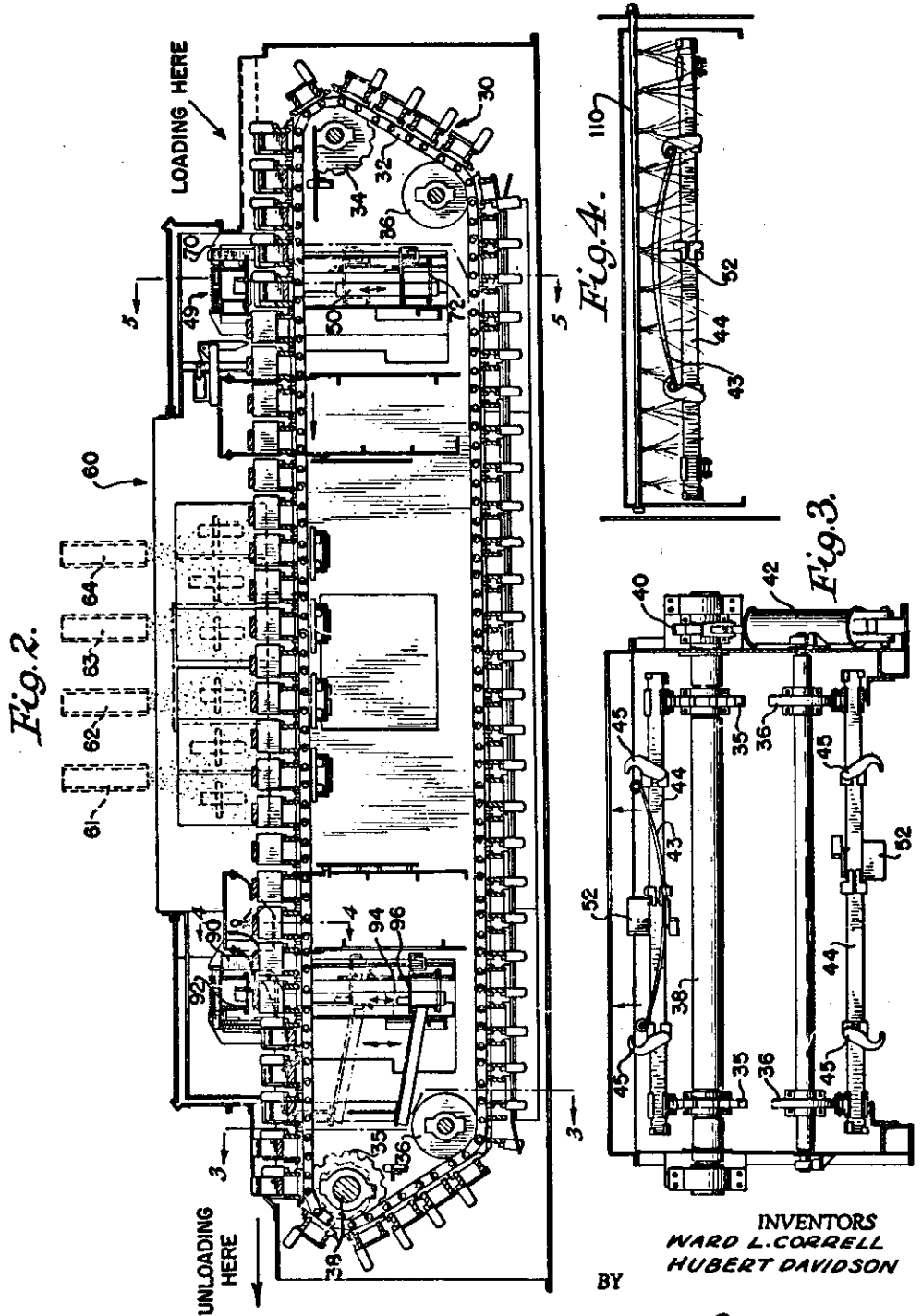
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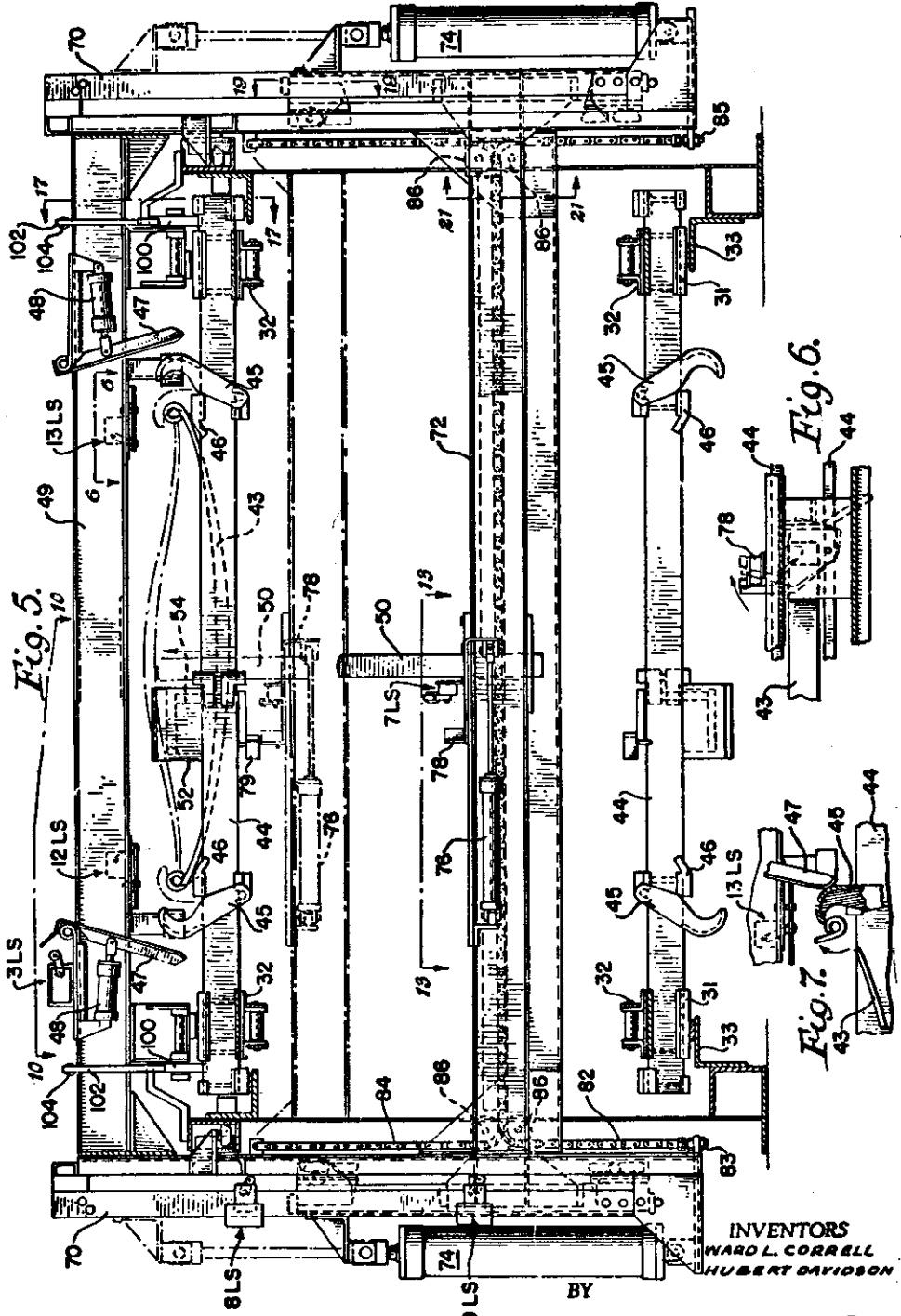
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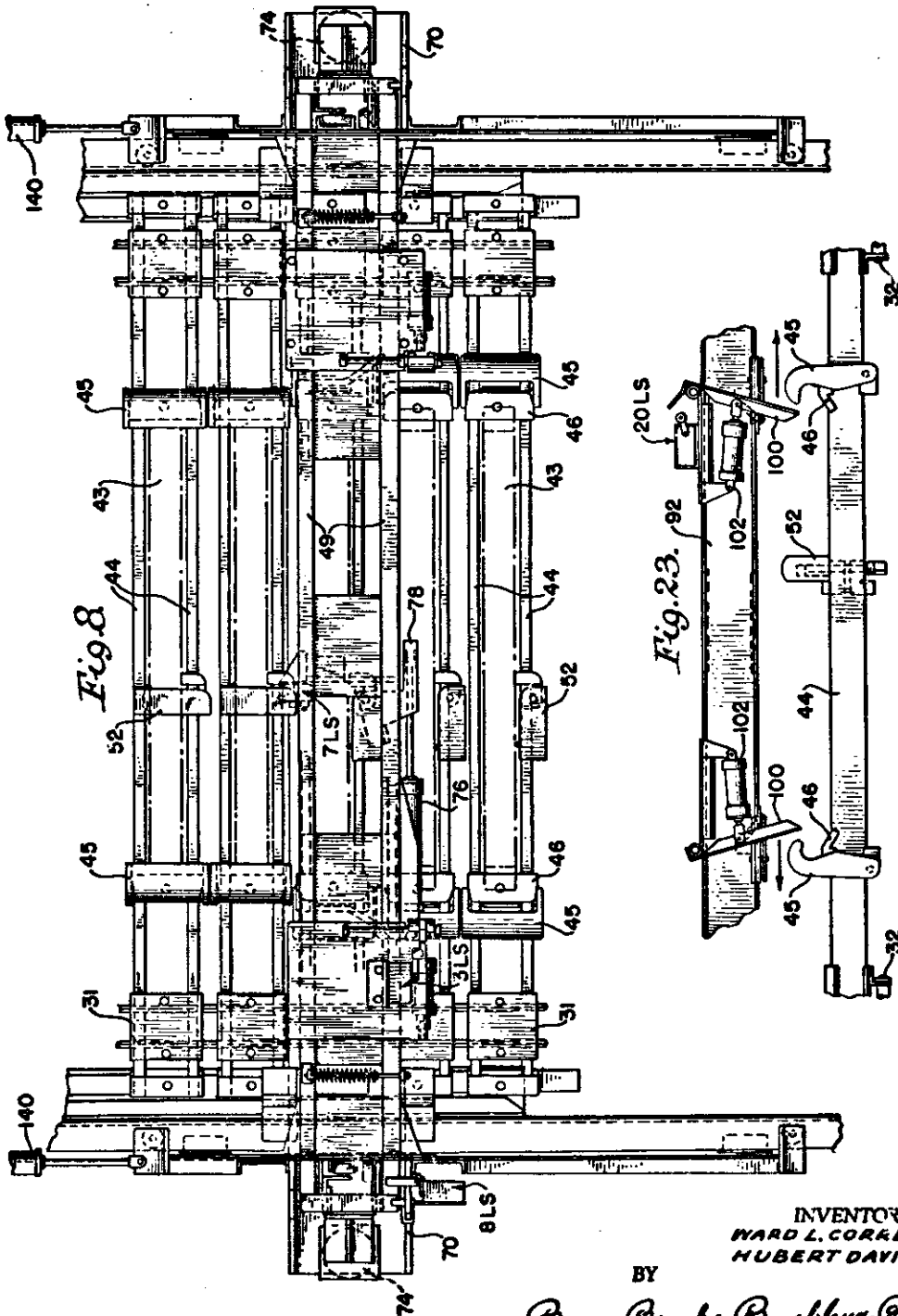
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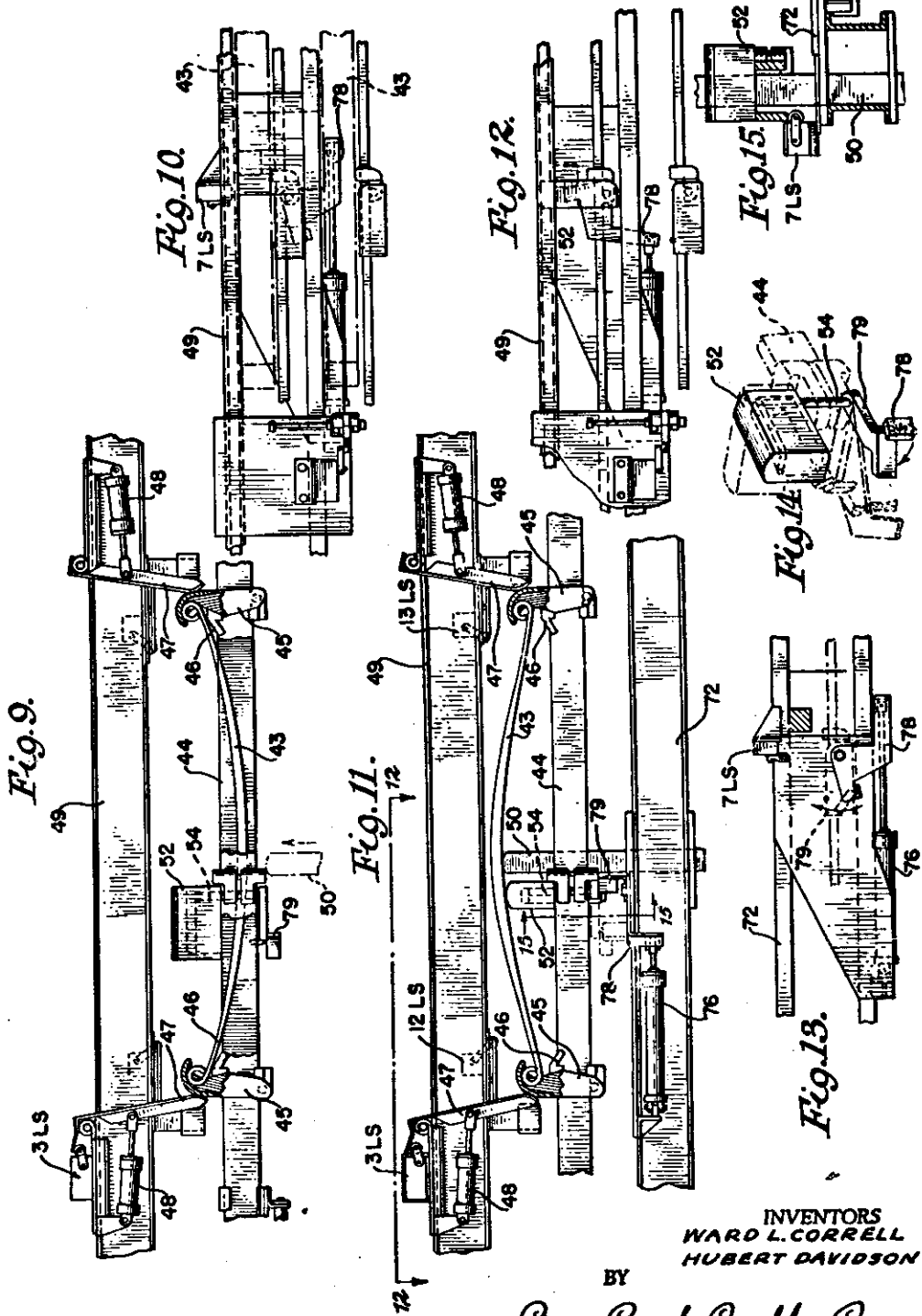
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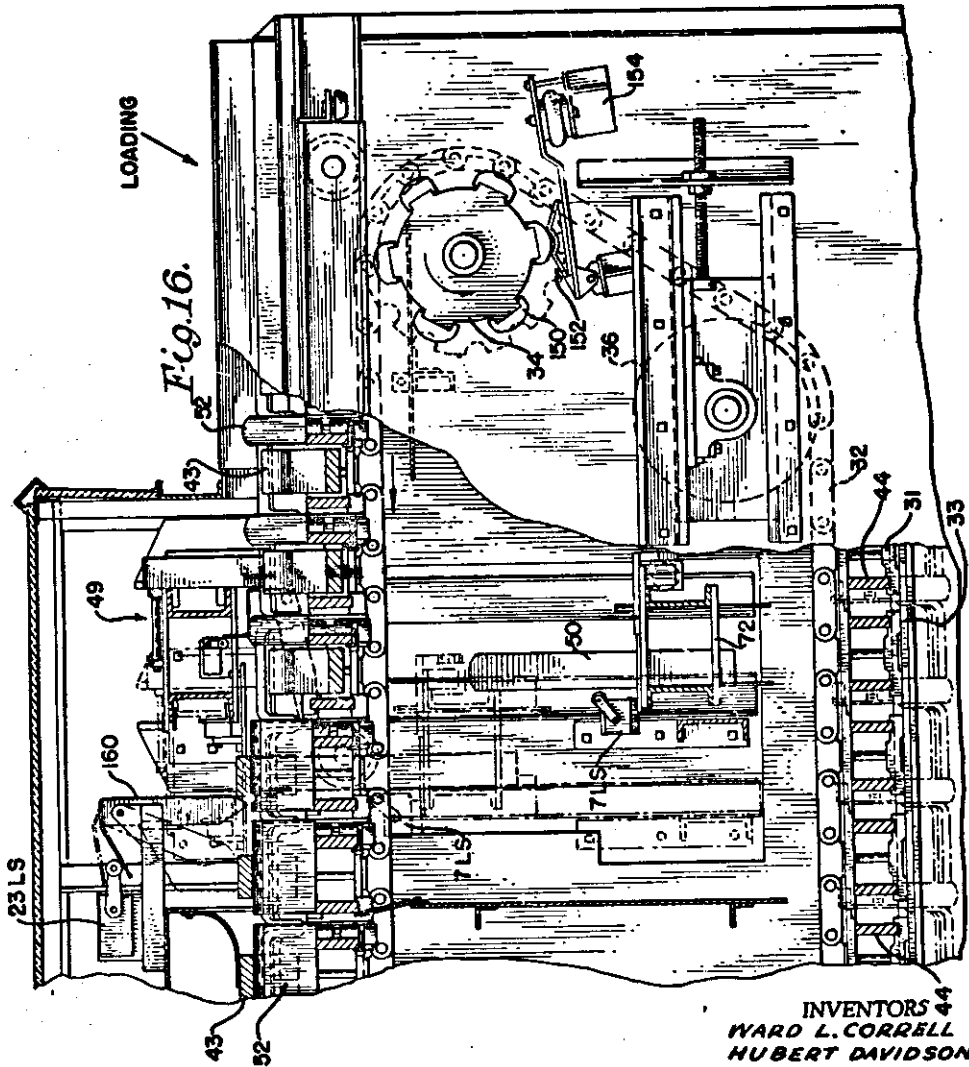
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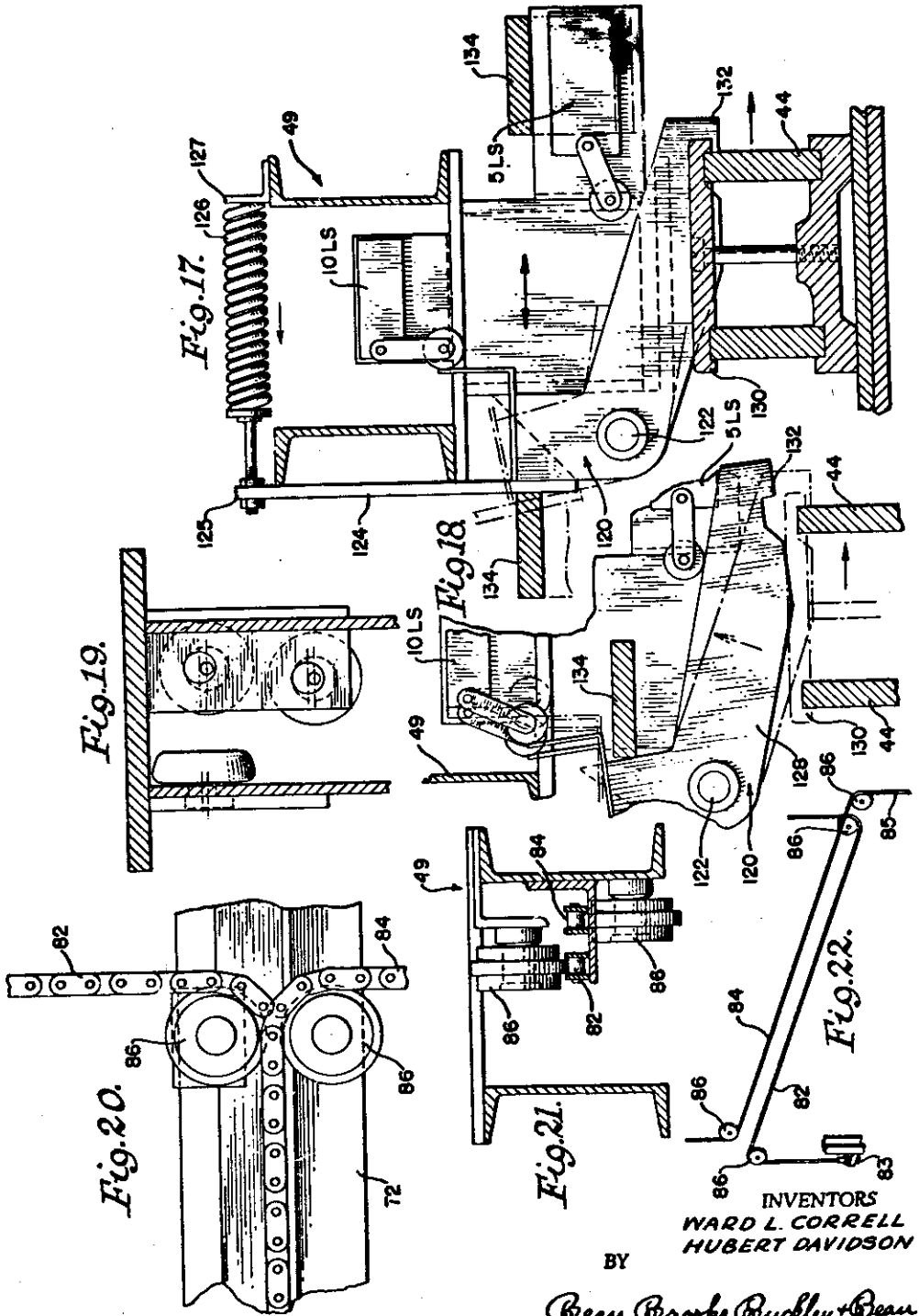
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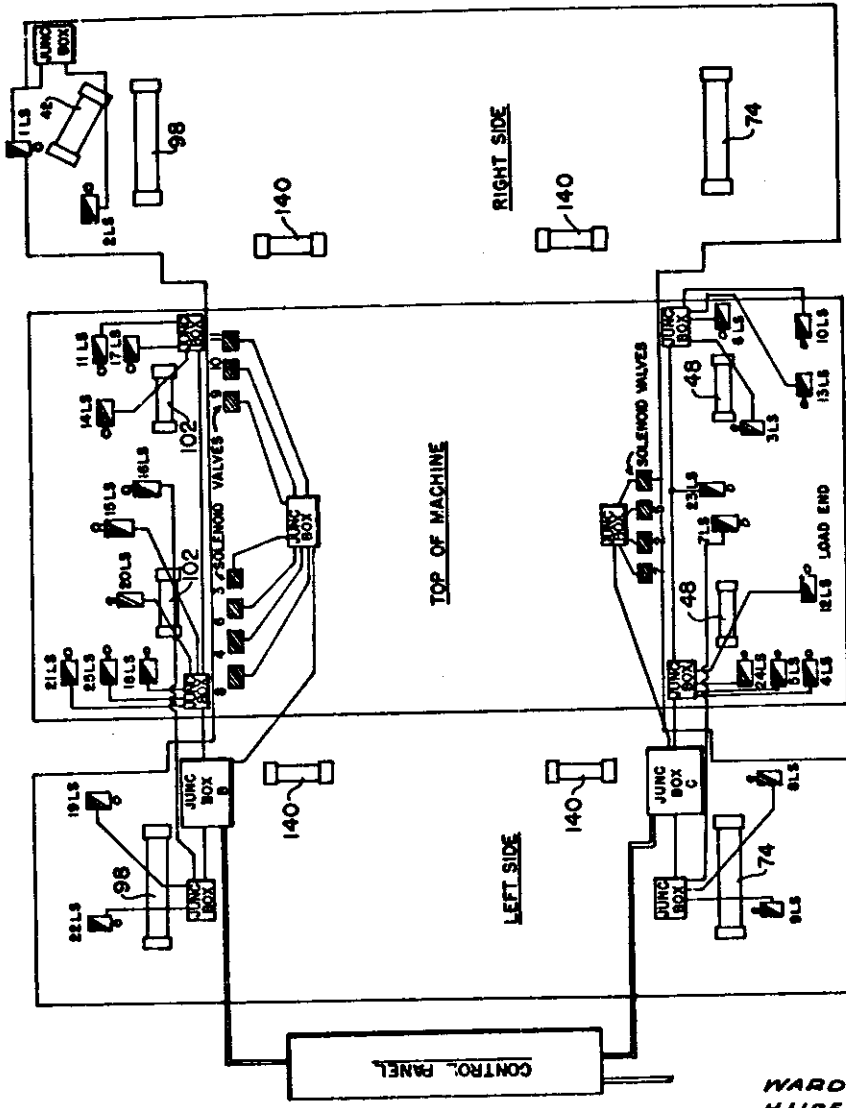


Fig. 2A

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